ESL-TR-99/12-04

Report of Energy Efficiency Study and Metering/Utilities Profile for Electricity Deregulation at the Texas A&M University-Corpus Christi (TAMU-CC) Corpus Christi, Texas

Submitted to

Texas A&M University-Corpus Christi
The Texas A&M University System

Submitted by

Yeqiao Zhu
Dan Turner
David Claridge

Energy Systems Laboratory
The Texas A&M University System

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Acknowledgement

The Electric Utility Regulation and Energy Efficiency Study for all universities in the TAMU System was initiated in May 1999 and is funded through an interagency agreement between the Chancellor's office and TEES's Energy Systems Laboratory. Detailed site visits were made to all system universities throughout the summer and fall. The Energy Systems Laboratory wants to thank all physical plant directors and their staff for their cooperation and support during the site visits.

Executive Summary

The physical plant director and staff at Texas A&M University-Corpus Christi (TAMU-CC) do a very good job of maintaining TAMU-CC and keeping expenses down. During our visit, however, we were able to identify several opportunities for energy efficiency.

Energy Savings Potential for the Campus

1. Estimated savings: $60,000/yr for top commissioning targets on the campus.
2. Estimated campus-wide savings: about $100,000/yr, if all the buildings are commissioned.

Commissioning Targets Ranked by Potential Energy Savings

1. Hot water boiler and hot water loop balancing
2. Chiller plant optimization
3. University Center
4. Center for the Arts
5. Center for Instruction
6. Bell Library
7. Natural Science Building
8. Early Childhood Center

Metering Recommendations for Electric Deregulation

Several options exist –split the signal from the main meter and install a separate ESL metering system, or purchase the utility interval data from CP&L. If the energy efficiency study is pursued, then hourly gas data will be necessary. Our recommendation is to install the ESL metering system and meter both the total gas and total electrical consumption for the campus. Fifteen minute electrical data are needed for any electrical deregulation program.

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Energy Efficiency Study

General Introduction

The TAMU-CC campus is located in Corpus Christi, Texas. The weather is very hot and humid in the summer and warm and humid in the winter.

There are 51 buildings on the campus with a total conditioned area of approximately 1,238,000 square feet of which 83%, or about 1,000,000 square feet has central air conditioning. The campus is the fastest growing campus within The Texas A&M University System.

The electricity and gas costs for 1998 were $958,830 and $69,758 respectively. This translates to about $0.83/yr/sq-ft for all of the buildings on the campus.

Three 1000 ton water-cooled chillers are located in the central plant and provide chilled water (ChW) to a loop for the campus and charge the chilled water to a thermal-storage tank as well. Two 400 hp boilers and one 5MMBtu/hr heat pump are located in the central plant and provide the hot water to the campus. One thermal-storage tank is located outside the central plant and is used to store the chilled water during non-peak periods and provide chilled water during the peak demand periods. The tank is 1,400,000 gallons and is 64 feet tall, and 61 feet in diameter. The total storage capacity is 12,000 ton-hours.

Three primary constant volume (CV) pumps circulate the chilled water across the chillers. Three secondary chilled water (ChW) pumps and most of building ChW pumps are equipped with variable frequency drives (VFDs). Most of hot water (HW) pumps are equipped with VFDs also.

The plant and most of the building HVAC systems are controlled by a Landis Insight 600 DDC system.

On August 17 to 19, 1999, we conducted a commissioning survey for the campus. A total of 12 buildings, the central plant, and the thermal storage system were inspected during the trip. The 12 major buildings were surveyed in detail and the measurements were also performed on most of air-handlers and pumps.

According to the information from the HVAC manager and plant operator, most of the systems are on 24-hour operation. Eight buildings have implemented nighttime shutdown and some setbacks for the room temperature setpoint and minimum CFM setpoint. Currently, the HVAC manager and/or operator provide the specifications and the Landis (Siemens) staff modifies the program.

Based on our survey results, the general mechanical systems are very well maintained. The campus is in a relative energy efficient condition. However, some energy savings potential has still been identified. Following is a summary of the results.

The layout of TAMUCC campus is shown in Figure 1.

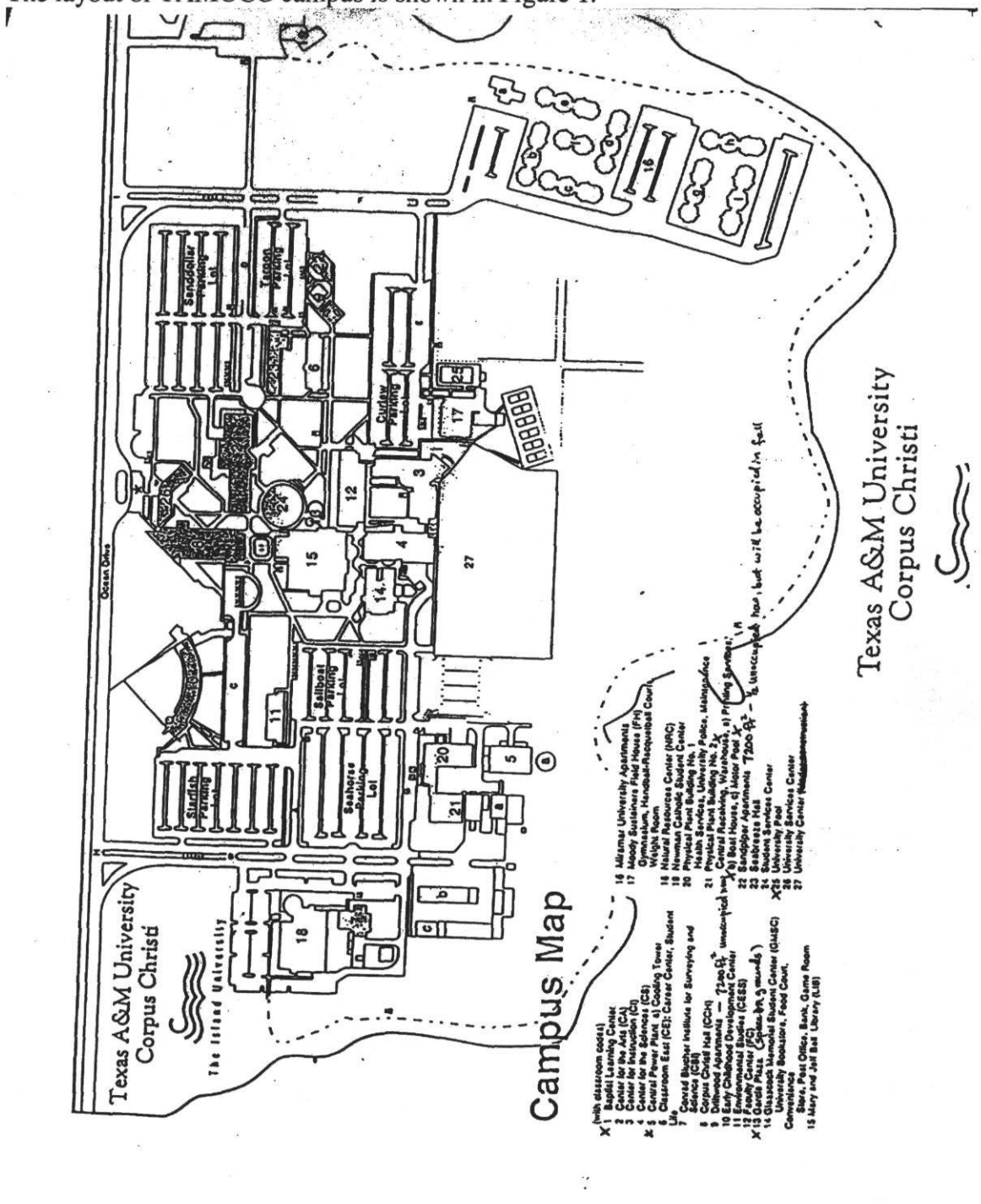

Figure 1. TAMUCC Campus and the Buildings

Energy Savings Potential for the Campus and the Commissioning Targets

Energy Savings Potential for the Campus

1. About $60,000/yr for the top commissioning targets in the campus.
2. Estimated campus-wide savings: about $100,000/yr.

Top Commissioning Targets Ranked by Energy Savings Potentials

1. HW boiler and HW loop
2. Chilled water risers
3. University Center
4. Center for the Arts
5. Center for Instruction
6. Bell Library
7. Natural Science Building
8. Early Childhood Center

Summary of Building Information and Major Recommended Energy Measures

University Center- New Student Center (offices, ballrooms, dining area, conference rooms, bank and other student activities)

Building Information
It is a 3-story building with an area of 95,733 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. Two hot water pumps are equipped with variable frequency drives (VFDs) and were running at 50% speed. The manual valve was partially open for the HW pump. The setpoint for the HW differential pressure (DP) was 12 psi. The ChW pump was running at 35Hz speed while the manual valve was partially open. The setpoint for the chilled water (ChW DP) was 12 psi. There are some 3-way valves for ChW lines of the air handler units (AHUs). The gauges for the pressure and temperature were not correct in the pump room.

A total of five single duct, variable air volume (SDVAV) AHUs and three single duct constant volume (SDCV) AHUs with HW reheat serve the building. For the SDVAVs, the fan speeds were from 27Hz to 45Hz. The static pressure setpoints ranged from 1" to 1.38". The discharge air temperature setpoints were 50°F for AHU-4 and 55°F for the other units. The manual valves were partially open for the HW and ChW lines. For the SDCV units, the discharge air temperature was 49°F for AHU-7. The cooling coil was hunting for AHU-8. The room temperatures were 67°F to 68°F for the ballroom, 68°F for the bookstore and 76°F for the 3rd floor.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loop.
2. Optimize the HW pumping system operation.
3. Optimize the static pressure reset schedule and discharge temperature setpoints.
4. Optimize the operating hours for some systems to satisfy the comfort and reduce operating costs.
5. Replace the gauges for the temperature and pressure in the pump room.

Center for the Arts (offices, classrooms, auditorium, arts rooms, and labs)

Building Information
It is a 3-story building with an area of 84,051 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was off. The ChW pump was running at 41% speed. The setpoint for the ChW DP was 15 psi.

A total of seven multi-zone AHUs and three SDCV AHUs with HW reheat serve the building. For the multi-zone units, the cold deck temperatures were 49°F and 53°F for AHU-9 and 11 respectively. Most of the multi-zone units had 55°F cold deck temperatures. For the SDCV units, the reheat coils heated the air by 5°F to 6°F for AHU-6 & 7. The pressure gauge on the suction side of the ChW pump was not working. The room temperatures were 64°F for the auditorium with no occupancy and 68°F for the small stage area. The system runs 24 hours a day for AHU-3 & 7. Other units had nighttime shut down from 24:00 to 6:00 on weekdays. Humidistats are used to control the coils for AHUs-5, 6 & 7.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loop.
2. Optimize HW pumping system operation.
3. Optimize the deck setpoints.
4. Optimize the operating hours for the building to satisfy comfort and reduce operating costs.
5. Balance the zones for multi-zone units.

Center for Instruction (offices, computer labs, and classrooms)

Building Information
It is a 3-story building with an area of 78,104 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot

water loop. The hot water pump has a variable frequency drive and was running at 69% speed. The setpoint for the hot water DP was 10 psi. The ChW pump was running at 52% speed while the manual valves were partially open for the loop. The DP setpoint for the ChW was 13 psi.

A total of six single duct VAV (SDVAV) AHUs, one constant volume single duct (SDCV) AHU and one two-speed fan single duct (SDCV with 2-speed) AHU serve the building. The static pressure setpoints were from 0.9" to 1.5". The VFD speeds ranged from 47% to 93%. The measured discharge air temperatures were from 52°F to 56°F for different AHUs. Most of the manual valves for the ChW lines were partially open. The SDCV AHU serves the two large classrooms with about 200 seats for each. The room temperatures were 68°F and 69°F for the classrooms. The lights were on even though the rooms were unoccupied.

One pretreatment unit (AHU-9) is used to provide the outside air to the AHUs. The discharge air temperature setpoint was 58°F with an actual temperature of 62°F.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Optimize the hot water loop pumping system operation.
3 Optimize the static pressure reset schedule and cold deck setpoint.
4. Optimize the OA intake.
5. Install a motion sensor for the classrooms, particularly the two large classrooms.
6. Investigate operating hours for the system.

Bell Library (library, offices, and book stacks)

Building Information

It is 2-story building with an area of 106,110 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water from the chilled water loop. Two ChW water pumps were running at 85% speed. The manual valve was partially open for the ChW pump. The temperatures for supply and return ChW were 42.8°F and 56°F respectively. Electric heating is used for the AHUs.

Five multi-zone AHUs serve the building. The cold deck temperatures varied from 51.6°F to 56°F for different AHUs. All the hot deck coil control valves were closed. Most of manual valves for the ChW line were partially open. The outside air dampers were full open for AHU-1A & 2A. The room temperatures were from 71°F to 72°F in the book stack area and 67°F for the computer area on the second floor. The air distribution was not balanced well for AHU 2-A because one return air stream was 75.6°F while the other return air stream was 71.6°F. The system was scheduled to shut down from 22:00 to 6:00 on weekdays.

Recommended Energy Measures

1. Optimize the chilled water differential pressure (DP) reset schedule for the building and balance the loop.
2. Reset hot deck & cold deck temperature setpoints.
3. Optimize the outside air intake.
4. Balance the air for AHU 2-A.

Natural Science-NRC (classrooms and offices)

Building Information
It is a 3-story building with an area of 95,285 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water from the chilled water loop. The ChW pump was running at 31Hz speed while the manual valves were partially open for the pump. The actual DP was 15.6 psi. The return water temperature reading was 62°F (from the building temperature gauge).

A total of fourteen single duct VAV (SDVAV) AHUs with electric reheat serve the building. One outside air pretreatment unit provides outside air to the AHUs. The fans are equipped with VFDs. The static pressure setpoints ranged from 1.25" to 1.74". The speeds ranged from 31Hz to 58Hz. The cold deck temperature setpoints were 56°F for all the AHUs. The measured cold deck temperatures were from 54°F to 56°F for the AHUs. Most of the manual valves for the ChW lines were partially open. The outside air intakes (OA) for AHU1-2, 1-4, 3-1, 3-2 & 3-3 were over 50% open. The cooling coil for the OA unit was manually closed. The temperature in a conference room was about 69°F. Some of the 3rd floor space had 74 ~ 75°F room temperatures.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Optimize cold deck and static pressure setpoint.
3. Optimize the OA intake.
4. Replace the gauge for the ChW return line of the building loop.
5. Investigate the operating hours for the system.

Early Childhood Center - pre-k to 3rd grade (classrooms, offices, library and conference rooms)

Building Information
It is a 2-story new building with an area of 53,416 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loop. The hot water pump was running at 42% speed. The manual valve was open for the HW pump. The setpoint for the HW DP was 7.5 psi. The ChW pump was

running at 28% speed while the manual valve was partially open. The setpoint for the ChW DP was 8.5 psi.

Two single duct VAV (SDVAV) AHUs with HW reheat serve the building. The supply fan speeds were 68% and 77% for AHU-1 & 2. The return fan speeds were 89% and 30% for AHU-1 & 2. The static pressure setpoints were 2.01" for AHU-1 & 2. The cold deck temperatures were 52°F and 56.5°F for AHU-1 & 2, respectively. The unit access door was partially open for AHU-2 (on the second floor). This caused a lot of cold air leakage.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Optimize the HW pumping system operation.
3. Optimize the static pressure reset schedule and deck setpoints.
4. Fix the access door for AHU-2.
5. Optimize the operating hours for the system to satisfy comfort and reduce operating costs.

Corpus Christi Hall (offices)

Building Information

It is a 2-story building with an area of 62,322 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loops. The hot water pump was off. One of two ChW pumps was running at 87% speed. The DP setpoint for the ChW was 30 psi.

Eight multi-zone AHUs serve the building. The cold deck setpoints varied from 52°F to 56°F for different AHUs. The measured cold deck temperatures were 54°F to 56°F for different AHUs. The heating coils were closed for all AHUs. The outside air (OA) intake was from 20% to 35%. For AHU2-3, the cold deck sensor had fallen out of duct. The cold air is leaking from this sensor hole. The system had a nighttime shut down schedule from 22:00 to 6:00 on weekdays.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Optimize the HW pumping system operation.
3. Optimize the deck temperature setpoint.
4. Optimize the OA intake and balance the zones.
5. Hook up the cold deck sensor for AHU 2-3.

Faculty Center (offices)

Building Information
It is a 2-story building with an area of 62,047 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water from the chilled water loop. One of two ChW pumps was running at 86% speed while the manual discharge valves were partially open. The ChW differential temperature across the building was 10°F.

Four multi-zone AHUs serve the building. Electric reheat is installed in every zone. The measured cold deck temperatures were from 54°F to 56°F for different AHUs. The system had a nighttime shut down schedule from 2200 to 0600 on weekdays.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Optimize the cold deck & hot deck temperature setpoints.

Center for Science (offices and classrooms)

Building Information
It is a 2-story building with an area of 51,877 sq-ft. The HVAC systems are controlled by a local pneumatic controller with Landis DDC control for the ChW pump only.

The building receives chilled water from the chilled water loop. One of two ChW pumps was running at 92% speed while the manual valve was partially open.

Eight SDCV AHUs with electric reheat units and one multi-zone unit serve the building. For the SDCV AHUs, the measured cold deck temperatures were from 52°F to 53°F for three AHUs. The room temperatures were from 64°F to 69°F for most of the area in the building. The lowest room temperature found was 62°F for Lab-240. All the cold deck and reheat are controlled by a local pneumatic thermostat. The system had a shut down schedule from 2200 to 0600 on weekdays. There was very little outside air intake for this building. The reason for the lower room temperatures is that the occupants set the thermostat to a very low setpoint.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Verify the system shut down schedule.
3. Adjust thermostats to 70°F and install security locks on the thermostats once the air flows are balanced and comfort problems are resolved.

University Services Center (offices)

Building Information
It is a 2-story building with an area of 21,284 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water loop and the hot water loops. The hot water pump was running at 57% speed. The manual valve was 20% open for the HW pump. The setpoint for the HW DP was 8 psi. The HW supply and return temperatures were 126°F and 109°F. The ChW pump was running at 76% speed while the manual valve was 50% open. The setpoint for the ChW DP was 18 psi.

Two single duct VAV (SDVAV) AHUs with HW reheat serve the building. The fan speeds were 42% and 63% for AHU-1 & 2. The static pressure setpoints were 1.5" and 1.02" for AHU-1 & 2. The cold deck setpoints were 56°F for two AHUs.

Recommended Energy Measures

1. Optimize the chilled water differential pressure reset schedule for the building and balance the loops.
2. Optimize the HW pumping system operation.
3. Optimize the static pressure reset schedule and deck setpoint.

Moody-Sustainers Field House (gym, racquetball rooms, small offices and equipment rooms)

Building Information
It is a 1-story building with an area of 26,005 sq-ft. The HVAC systems are controlled by a Landis DDC system.

The building receives chilled water and hot water from the chilled water and the hot water loop. The ChW pump was running at 40% speed.

A multi-zone unit serves the racquetball rooms. A single duct unit with HW reheat serves the bathrooms, small offices, weight rooms and some PE equipment rooms. Four single duct cooling only units serve the big Gym area. In the Gym, gas space heating is installed. The Gym had a room temperatures of 69.4°F and was lightly occupied.

Recommended Energy Measures

1. Shut down the system for the big gym area during unoccupied hours.
2. Run two or one units for the gym area when it is lightly occupied.

Student Services Center (offices)

Building Information
It is a 2-story building with an area of 23,016 sq-ft. The HVAC systems are controlled by local thermostats.

The building receives chilled water from the chilled water loop.

Eight SDCV AHUs with electric reheat serve the building. The cooling coil and reheat temperatures are controlled by the zone thermostat.

Summary of Plant Information and Recommended Energy Measures

Plant Information

Three 1000 ton water-cooled chillers are located in the central plant and provide chilled water (ChW) to a loop for the campus and charge the chilled water to a thermal-storage tank as well. The thermal-storage tank is located outside the central plant and is used to store the chilled water during non-peak periods and provide chilled water to the campus during the peak demand periods. The 1,400,000 gallon tank is 64 feet tall and 61 feet in diameter. The total capacity is 12,000 ton-hours. The tank is actually acting as a blending station. When the buildings need less chilled water, more chilled water will flow to the tank. There is no control valve or special pump for the tank. The control for the tank is very simple. Currently, the electricity will drop about 1100kW for the peak demand periods by the use of the thermal-storage tank. The first chiller will be on line at 1925, the second one will be on line at 2000 to recharge the tank. During the daytime, the first chiller will be off line at about 1125, the second one will be off line at about 1200 to 1220, prior to CP&L's peak demand period.

Three primary 40 hp constant volume pumps circulate the chilled water across the chillers. Three 200 hp secondary pumps and most of building ChW pumps are equipped with VFDs. The secondary loop pumps pump the chilled water from the chiller or from the tank to the building. The primary loop pump will be on when the chillers are on and will be off when the chillers are off. The condenser water pumps are constant volume pumps with 75 hp for each. Three 75 hp condenser fans are equipped with VFDs.

The chilled water loop is shown in following figure.

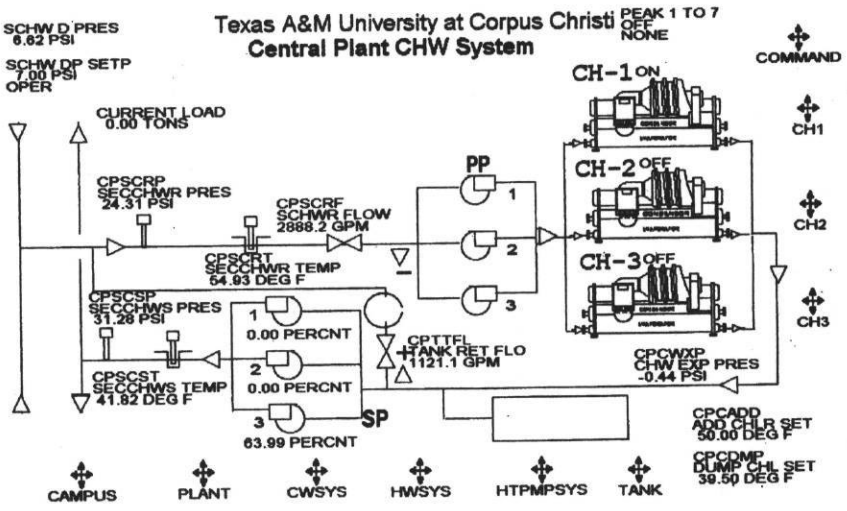

Figure 2: The Chilled Water Systems

Note: the chilled water flow GPM reading was not right.

Two 400 hp boilers and one 5MMBtu/hr heat pump are located in the central plant and provide the hot water to the campus. Most HW pumps are equipped with VFDs also. During the visit, one boiler was used to generate the hot water to the campus.

Recommended Energy Measures

1. Optimize the ChW pumping system operation.
2. Optimize the HW pumping system operation.

Electricity Deregulation Metering Options

The electric utility metering for the TAMU-CC Campus is fairly straightforward. There is a single meter for the entire island, of which 99% of the load is the TAMU-CC campus. A church on the island is separately metered, and their energy consumption is subtracted from the total bill to get TAMU-CC's consumption.

CP&L can provide 15-minute interval data for TAMU-CC at a nominal cost which is added to the monthly bill. Alternatively the Energy Systems Laboratory (ESL) can install a data logger and split the signal from the utility. Either way we proceed, the 15-minute interval data will need to be transmitted to the Energy Systems Laboratory for archival and eventual load aggregation if the TAMUS proceeds with the electric deregulation through Phase II.

If the interval data is obtained from CP&L there will be a charge each month added to the utility bill. The ESL costs will be for archival (and aggregation). The cost for the Phase II electric deregulation will be about $4,000 if we obtain the data from CP&L and about $8,000 if the ESL installs a stand-alone system which parallels the CP&L meter and polls the data each week.

Utility Bill Summary

TAMUCC							
	Electricity				Major Natural Gas		
Month	Energy -kwh	Energy Cost $	Demand-kW	Demand Costs $	Gas-MCF	Gas Cost $	Total cost
Jan-98	1,564,385	65,983	1,654		1,609	6,006	71,989
Feb-98	1,844,935	83,293	1,647		1,463	5,189	88,482
Mar-98	1,564,175	67,395	1,660		1,605	5,393	72,788
Apr-98	1,597,455	84,071	3,163		1,232	4,639	88,710
May-98	1,856,215	92,681	3,422		1,669	6,409	99,090
Jun-98	1,888,015	93,516	3,392		1,915	7,290	100,806
Jul-98	1,868,455	93,831	3,470		1,889	6,884	100,715
Aug-98	1,813,535	87,811	3,478		1,232	4,132	91,943
Sep-98	1,972,135	92,056	3,541		1,376	4,279	96,335
Oct-98	1,825,935	67,329	1,479		1,578	4,951	72,280
Nov-98	1,752,215	66,883	1,619		1,378	5,041	71,924
Dec-98	1,555,255	63,981	1,769		2,740	9,546	73,527
total/max	**21,102,710**	**958,830**	**3,541**		**19,686**	**69,758**	**1,028,588**
Jan-99	1,747,200	68,126	1,754		1,932	7,271	75,397
Feb-99	2,083,200	78,845	1,536		1,680	6,081	84,926
Mar-99	1,591,815	65,928	1,479		1,958	7,091	73,019
Apr-99	2,003,535	98,424	3,589		1,759	6,384	104,808
May-99	1,915,200	96,944	3,697		806	3,307	100,251
			3,697				
Demand charge is included in the energy costs.							
CP&L: Central Power and Lighting Company							
City of CC: City of Corpus Christi							
Major Natural Gas: the sum of the four meters of Central Plant, Gym, Center for the Arts and University Center							